Article

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Research Article

The Effect of Sandy Surfaces on Touch DNA

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Abstract

Touch DNA profiling is an important tool to solve the mystery of many cases, especially when other biological evidences cannot be found in crime scene. However, there are many variables that influence Touch DNA profiling such as recovery techniques and extraction. In addition, effect of environmental factors on items found outdoor such as sand can impact on the process. Therefore the aim of this experiment was to test how sandy surfaces can affect the recovery of Touch DNA Profiling by validation two recovery methods and two extraction kits that are widely used in the DNA forensic field.

Keywords: DNA recovery; Forensic DNA; PrepFiler Express BTA™; QIAamp® DNA Investigator; Quantifiler™ Human DNA Quantification Kit; Touch DNA

Introduction

Touch DNA profiling is an important tool to solve the mystery of many cases, especially when other biological evidences cannot be found in crime scene. However, there are many variables that influence Touch DNA profiling such as recovery techniques and extraction [1-3]. In addition, heat and humidity on items found outdoor can reduce or loss of trace DNA [4,5]. Another issue with environmental factors that can influence Touch DNA recovery on items found outdoor is dust or sand, especially in hot climates such as Dubai where sands move all the time because of the winds.

Therefore the aim of this experiment was to test how sandy surfaces can affect the recovery of Touch DNA Profiling by validation two recovery methods and two extraction kits that are widely used in the DNA forensic field.

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Materials and Methods

Experimental set up and deposition

A selection of four surfaces (stainless steel; smooth non-porous, glass; smooth non-porous, textured wood; rough porous and textured plastic; rough non-porous) were chosen to replicate common items encountered in crime scenes and to have a variety of surfaces. All non-porous surfaces were sterilised by 2% virkon and ultraviolet radiation (UV) for 15 min, and only textured wood was irradiated with UV for 25 min.

For DNA deposition, a participant was asked to wash his hands with antibacterial soap and refrain from undertaking any activity for 10 minutes. Then, charge the fingers of both hands with eccrine sweat by touching behind their ears or forehead to load them with enough DNA. The participant was then asked to touch the surfaces using their index, middle, and ring fingers of both hands separately for deposition by applying medium pressure on 5 x 7 cm area of the surface for 1 minute. The same procedure was repeated on all the surfaces for equal deposition on each surface.

After deposition of DNA, sand from Dubai (common sand found outdoors) was left on the surfaces, which were then placed in High temperature with moderate humidity (40°C/50%) for three hours to simulate Dubai weather (n=48 – three replicates for each variable).

DNA recovery and extraction

Two methods were used to recover the touch DNA, Copan cotton swab (150C) (CS) and Copan nylon flocked swab (4N6 FLOQSwabs®) (NS). Before collection, 100µL of sterile distilled water was applied to moisten CS using a plastic spray bottle technique (developed in Dubai police forensic DNA lab; each single spray contains approximately 50µL). For NS, 30µL of sterile distilled water was applied to moisten the swab using a pipette as recommended by the manufacturer.

Full swabs head were extracted by PrepFiler Express BTA™ kit (Thermo Fisher Scientific) (EX1) using an AutoMate Express Forensic DNA Extraction System according to the manufacturers' recommendations and manually using the QIAamp® DNA Investigator Kit (Qiagen) (EX2) as per the manufacturers' protocol. However, with EX2 nylon swabs were extracted using NAOBasket™ as recommended by Copan to increase the DNA yield.

DNA quantification, amplification and analysis

Extracted samples were quantified using the Quantifiler® Human DNA Quantification Kit, Quant Studio 5 Real-Time PCR (qPCR) and HID Real-Time PCR analysis software v1.3 according to the manufacturer's instructions (Thermo Fisher Scientific). Amplification was performed using the Global Filer™ PCR Amplification Kit (Thermo Fisher Scientific) according to the manufacturer's recommendation, following 30 cycles protocol.

Then the data were analysed using GeneMapper® ID-X Software Version 1.2 (Thermo Fisher Scientific). Statistical analysis on the tested variables was performed with RStudio using factorial analysis of variance (ANOVA). Blanks were taken from surfaces after sterilization, and negative controls for the collection and extraction methods, all of which were negative for DNA when quantified.

Results and Discussion

The amount of DNA collected from the sandy surfaces was significantly affected by collection method ($F_{1,32} = 7557.47$, $p < 0.05$), extraction type ($F_{1,32} = 817.26$, $p < 0.05$) and the interaction between collection and extraction ($F_{1,32} = 172.22$, $p < 0.05$) (Figure 1).

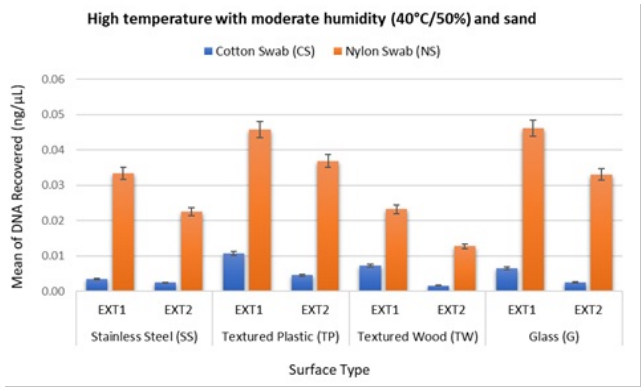

Figure 1: Amount of DNA recovered from four sandy surfaces (n = 48) using cotton and nylon swabs, then extracted by PrepFiler Express BTA™ kit (EX1) and QIAamp® DNA Investigator Kit (EX2). Error bars represent 95% confidence intervals.

Samples performed better when extracted by PrepFiler Express BTA™ kit (EX1) than the QIAamp® DNA Investigator Kit (EX2), when the collected swabs contained sand. Nevertheless, the Nylon Swab was the best performer of collection touch DNA from the sandy surfaces, when compared to cotton swabs (Figure 2). When using both swabs to collect DNA from the sandy surfaces, the cotton swab collected much more sand than the nylon swab. That can be caused by the amount of distilled water used with the swabs (100µL with cotton swab and 30µL with nylon swab), or the fact that the cotton swab retains much more sand.

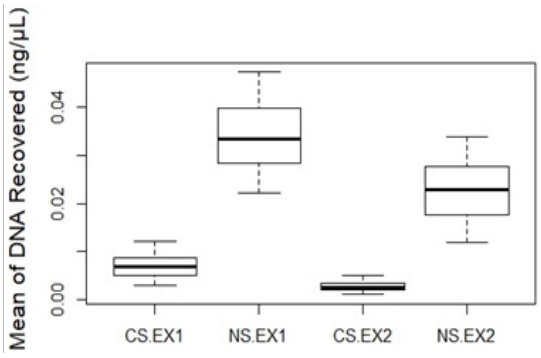

Figure 2: The mean of DNA recovered from the sandy surfaces (n=48) using cotton (CS) and nylon swabs (NS), then extracted by PrepFiler Express BTA™ kit (EX1) and QIAamp® DNA Investigator Kit (EX2). Error bars represent standard Error.

Samples collected from stainless steel were amplified to validate the quality of samples collected. Samples collected by nylon swab produced full profiles, and samples collected by cotton swab produced almost full profiles with few allele dropouts (Figure 3).

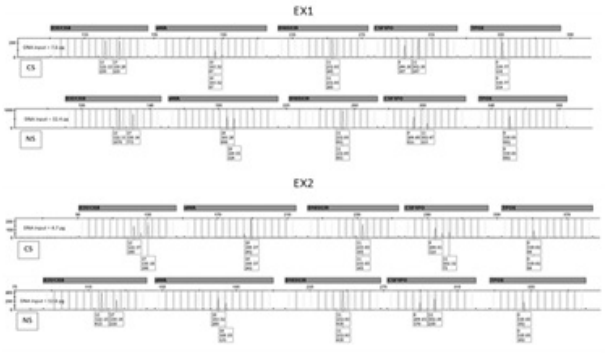

Figure 3: Samples collected from nylon swab and Cotton swab.

Conclusion

Sand on the surfaces found outdoors can influence the amount of the DNA recovered from touched items. A nylon swab is an advisable to use as a collection method from items found outdoors in sandy environments such as Dubai, in combination with the PrepFiler Express BTA™ extraction kit.

Conflict of Interest

None.

Acknowledgements

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